

Residential Energy in Context

Just Enough Thinking About Just
The Right Things

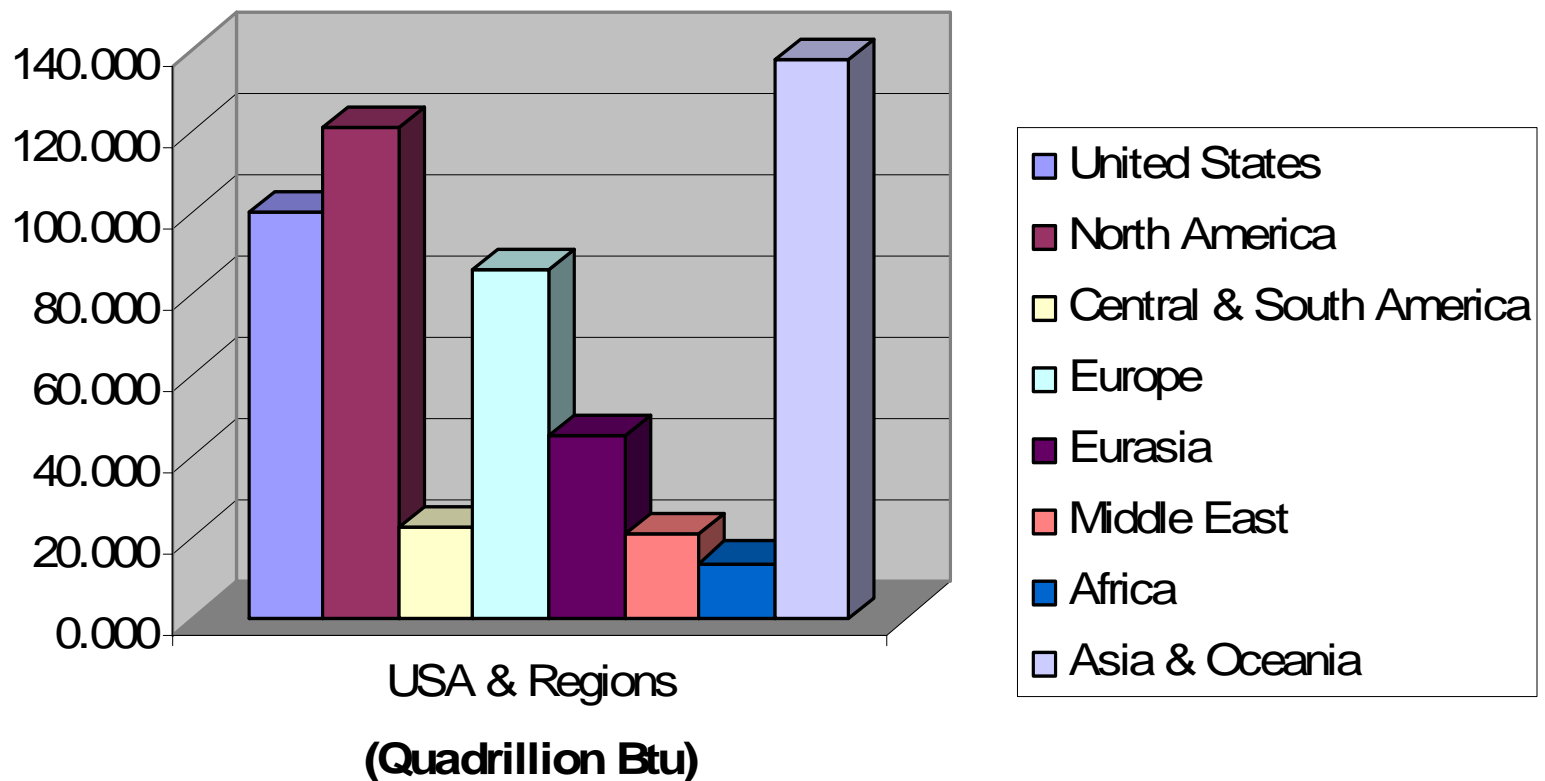
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Energy Efficiency Considerations

- Energy Consumption Patterns
- Residential Energy Choices
- Some Ideas About Good Building
- Energy Auditing
- Conclusion

Energy Use: World Totals

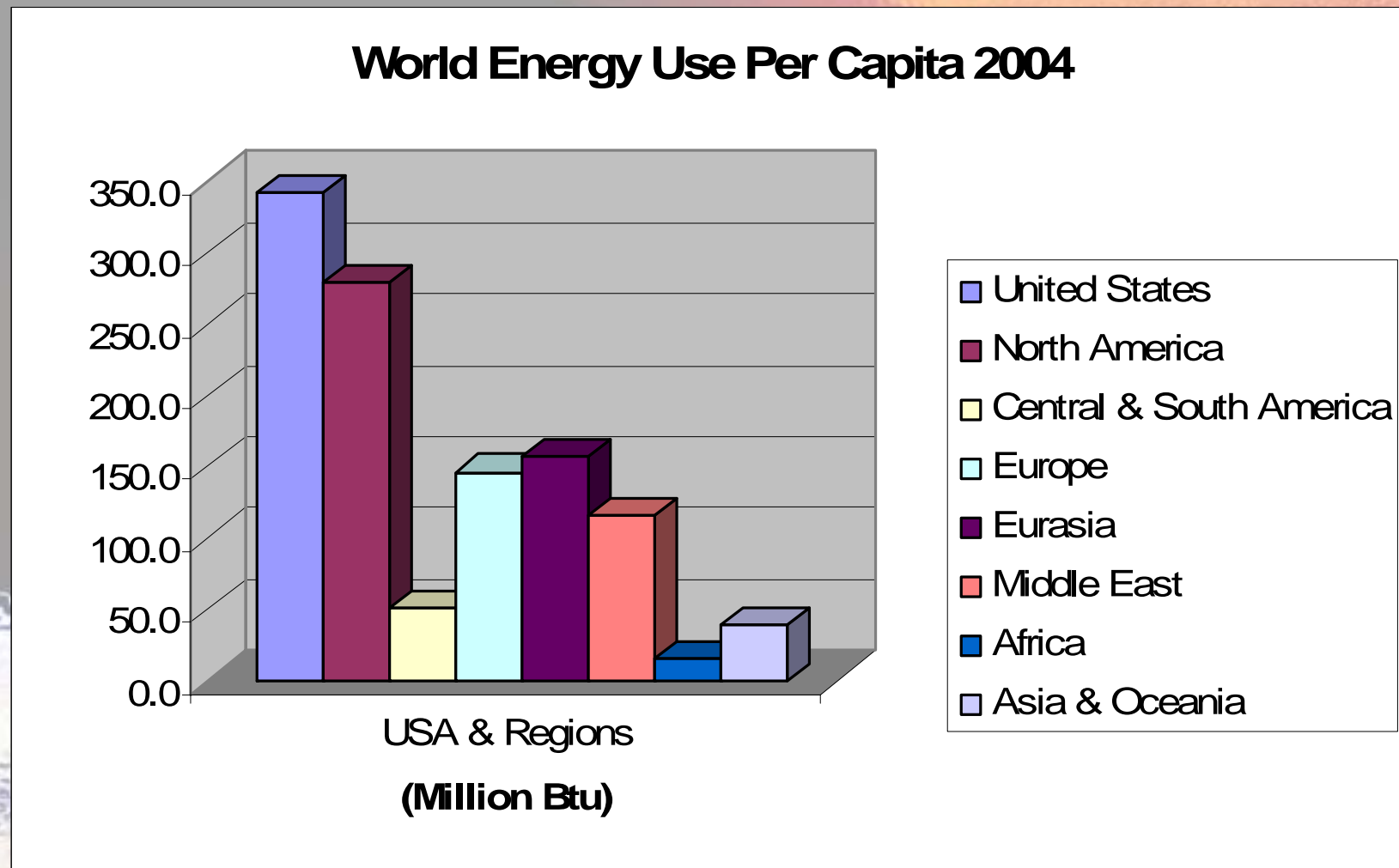
World Primary Energy Consumption 2004



Source: US EIA

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Energy Use: World Per Capita



Source: US EIA

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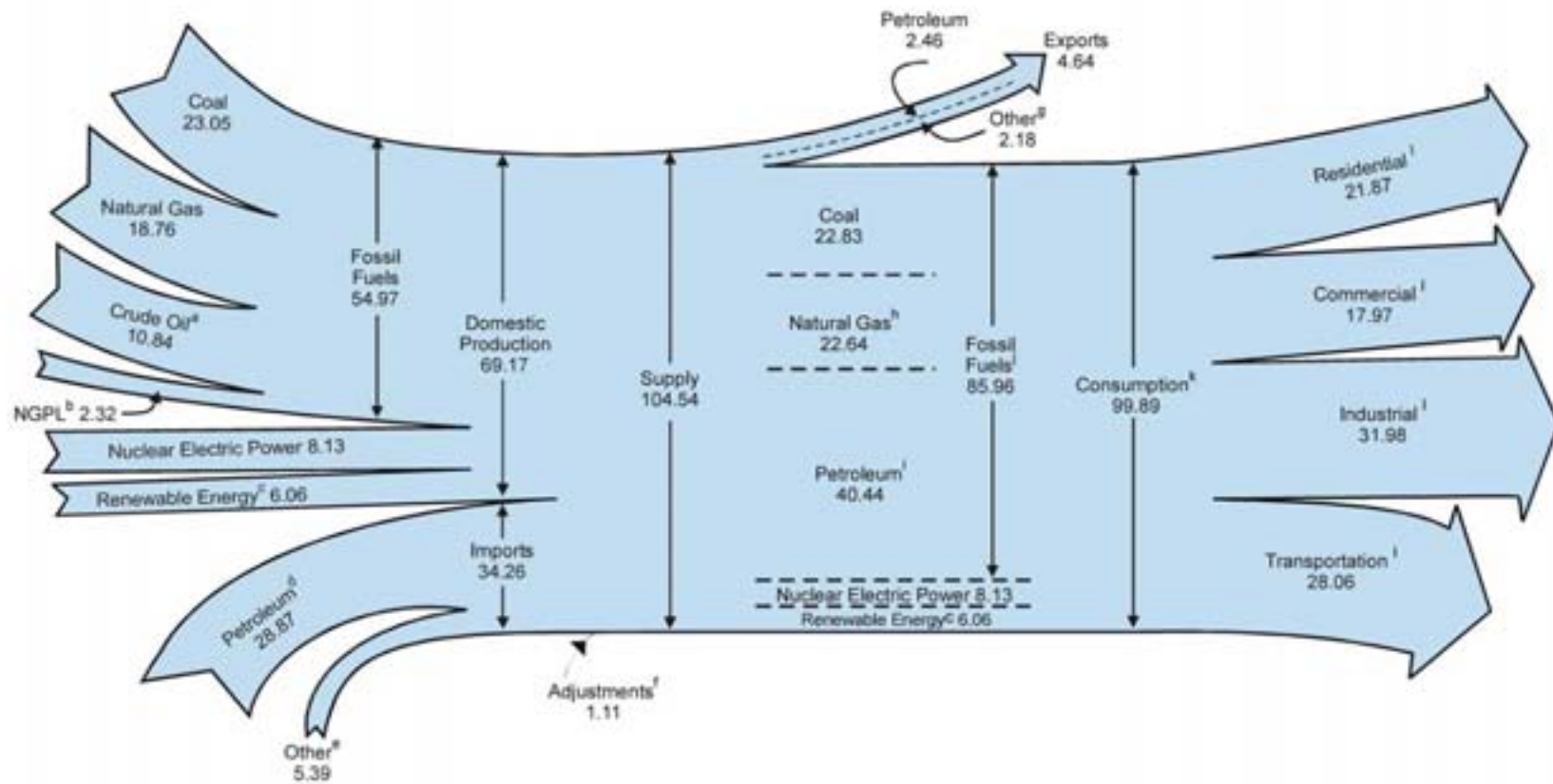
Energy Use: World Per Capita

The construction and operation of buildings consumes over a third of the world's energy consumption, and 40% of all the mined resources.

Buildingscience.com

Energy Use: US Flow

Energy Flow, 2005
(Quadrillion Btu)

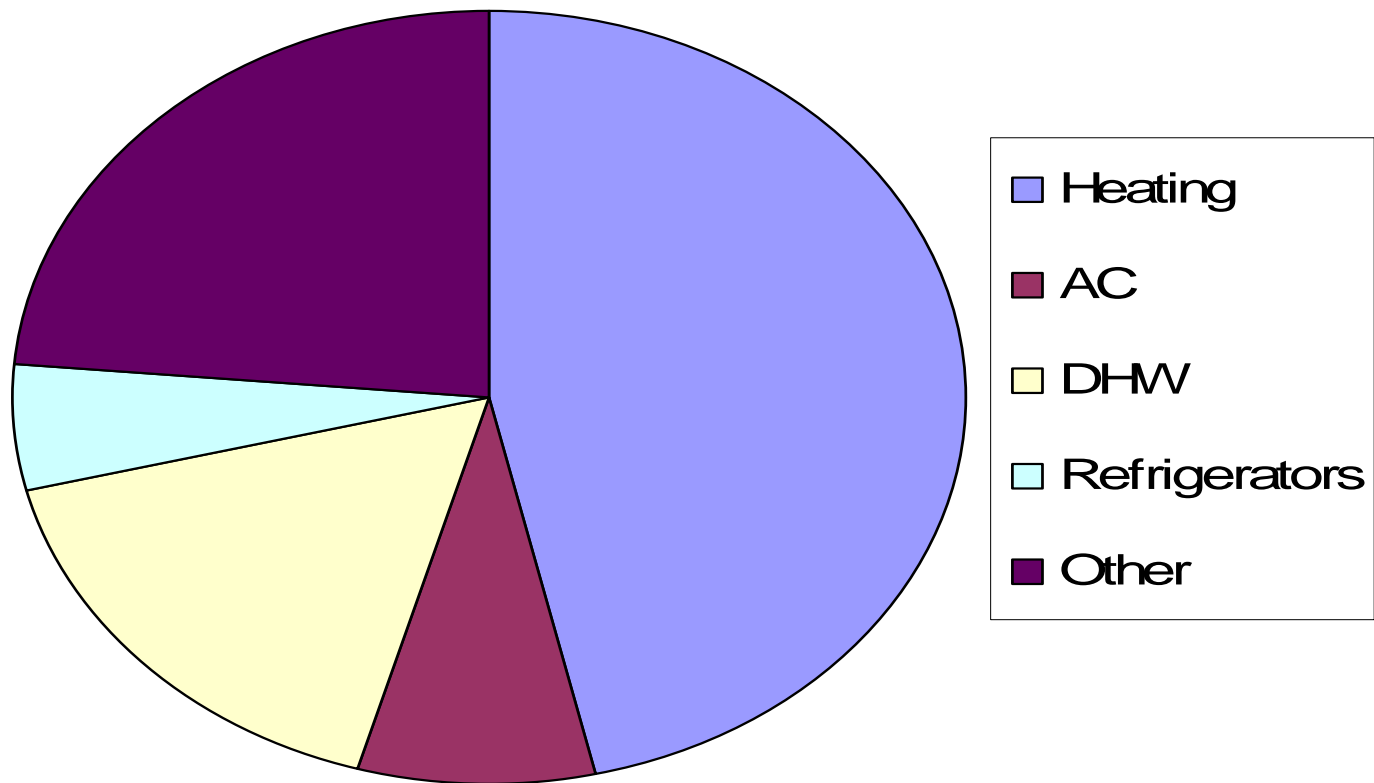


Source: US EIA

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Energy Use: Residential

US Residential Energy Consumption 2001



Source: US EIA

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Regional, Local, Site Issues

– Climate Characteristics:

- HDD, CDD
- Insolation

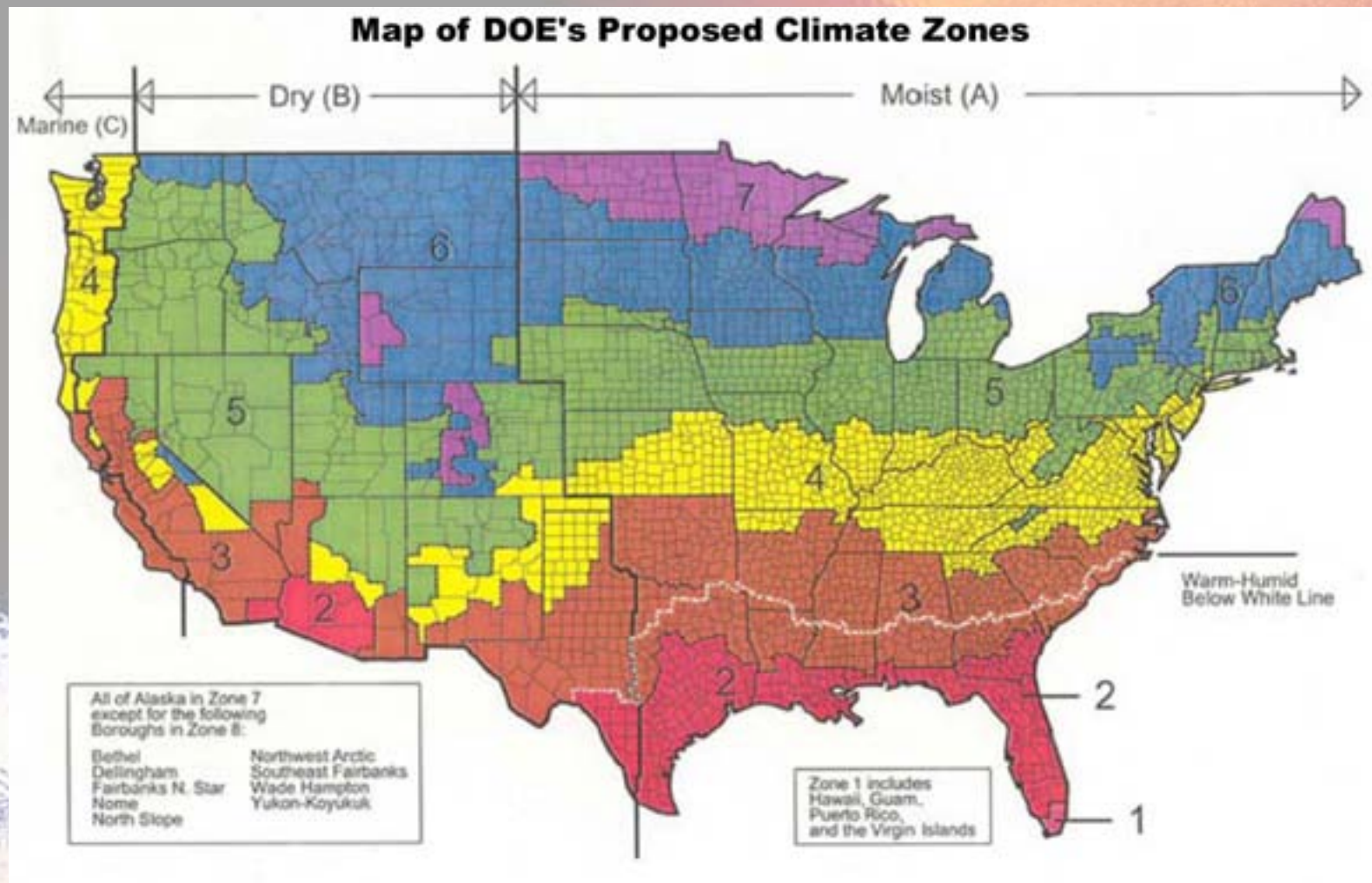
– Siting:

- N-S vs. E-W Orientation
- Trees

– Building Characteristics

- Corners
- Cantilevers
- Roof

Our Region



Source: US DOE

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Our Region



Source: BuildingSciences.Com

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Changing Ideas About Energy Efficiency

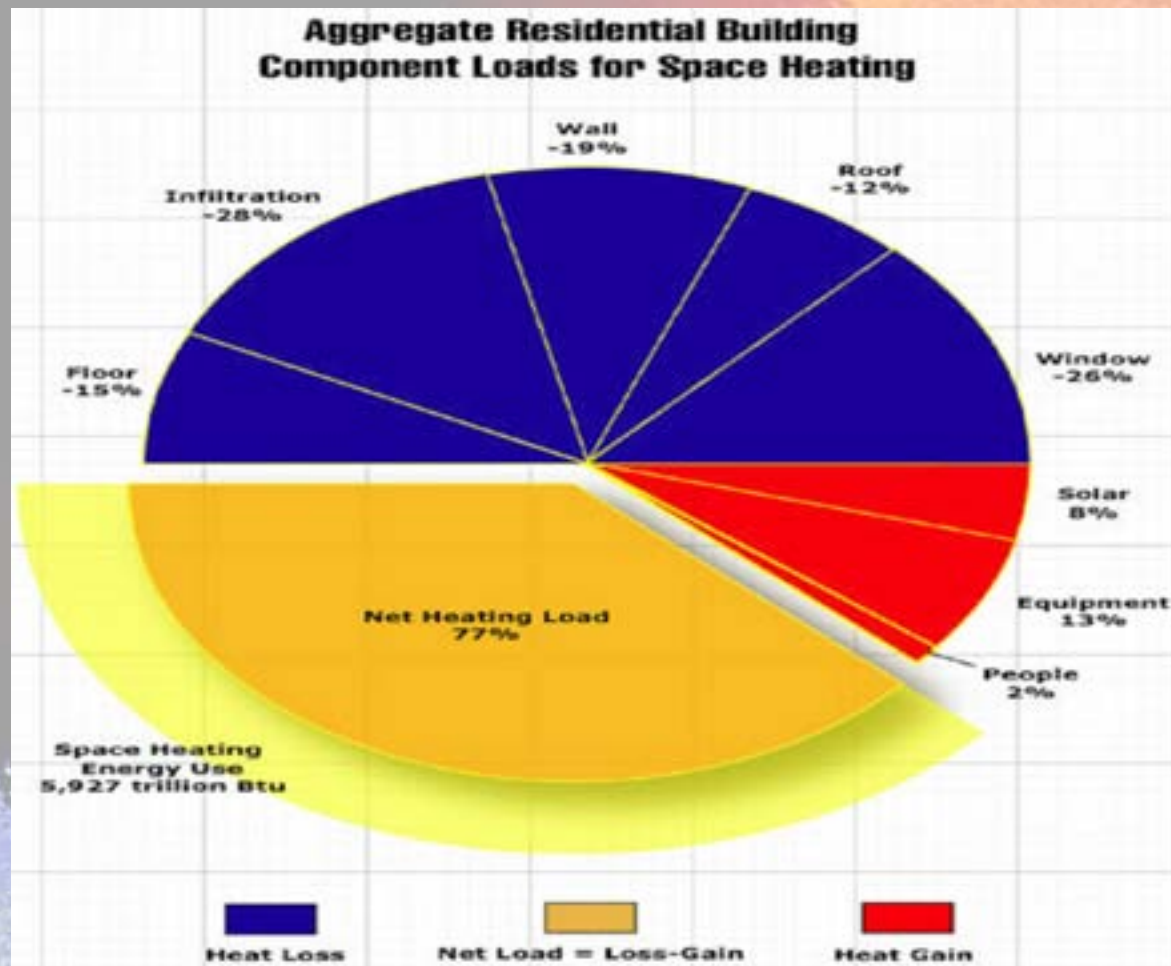
Building Technologies Change With:

- Better Science & Understanding
- New/Newly Applied Materials
- New Expectations

Some Ideas About Good Building

- Air Infiltration
- Hot Roofs
- Crawl Spaces
- Ventilation & IAQ
- Heating & AC
- Hot Water
- Fuel Choices

Heating Our Homes



Source: US EIA

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Air Leaks

- Air Barriers vs. Vapor Barriers
- Wind & Stack Effect
- Ventilation Fan Depressurization
- Duct Systems & Envelopes

Air Leaks

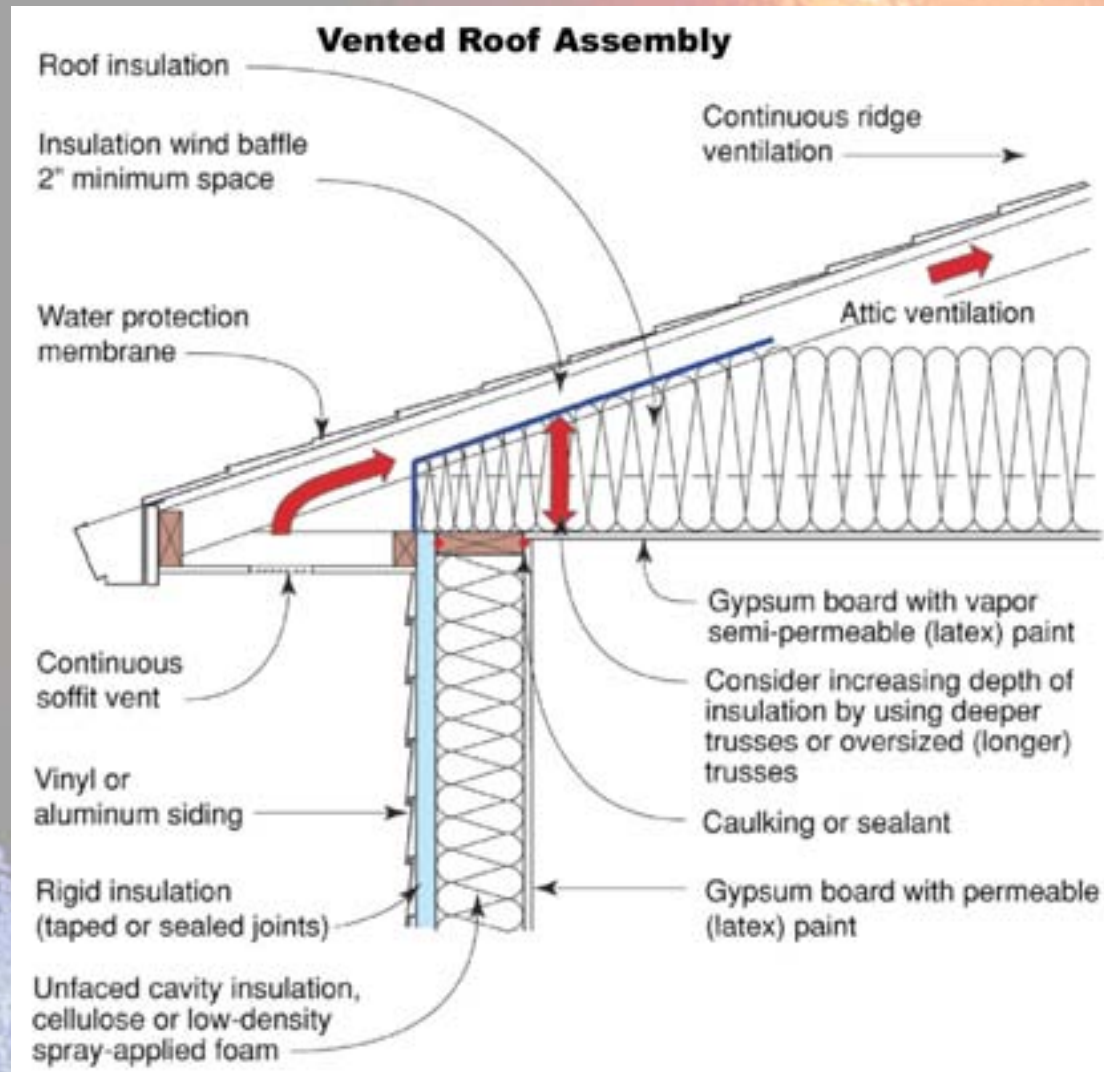
Water Intrusion

- Holes
- Permeance
- Condensation & Dew Points

Roofs

- Vapor Ventilation
 - Structural Complexity
- Hot Roof Approach

Roofs

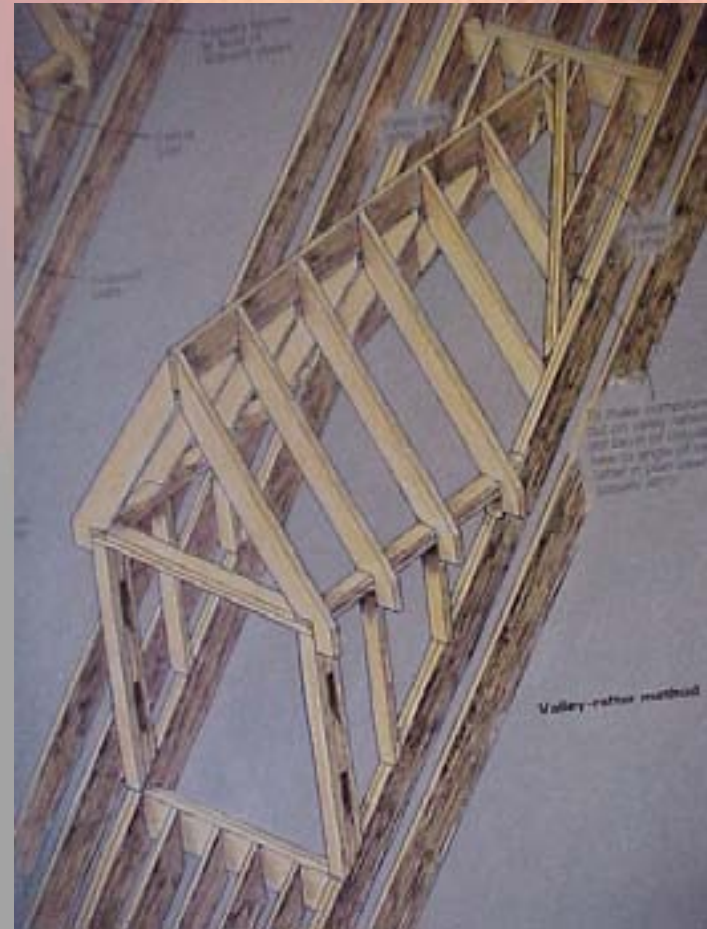


Source: BuildingScience.Com

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Roofs

- Framing Complexities
 - Hips
 - Valleys
 - Jack Rafters
- Attic vs. Roof Ventilation



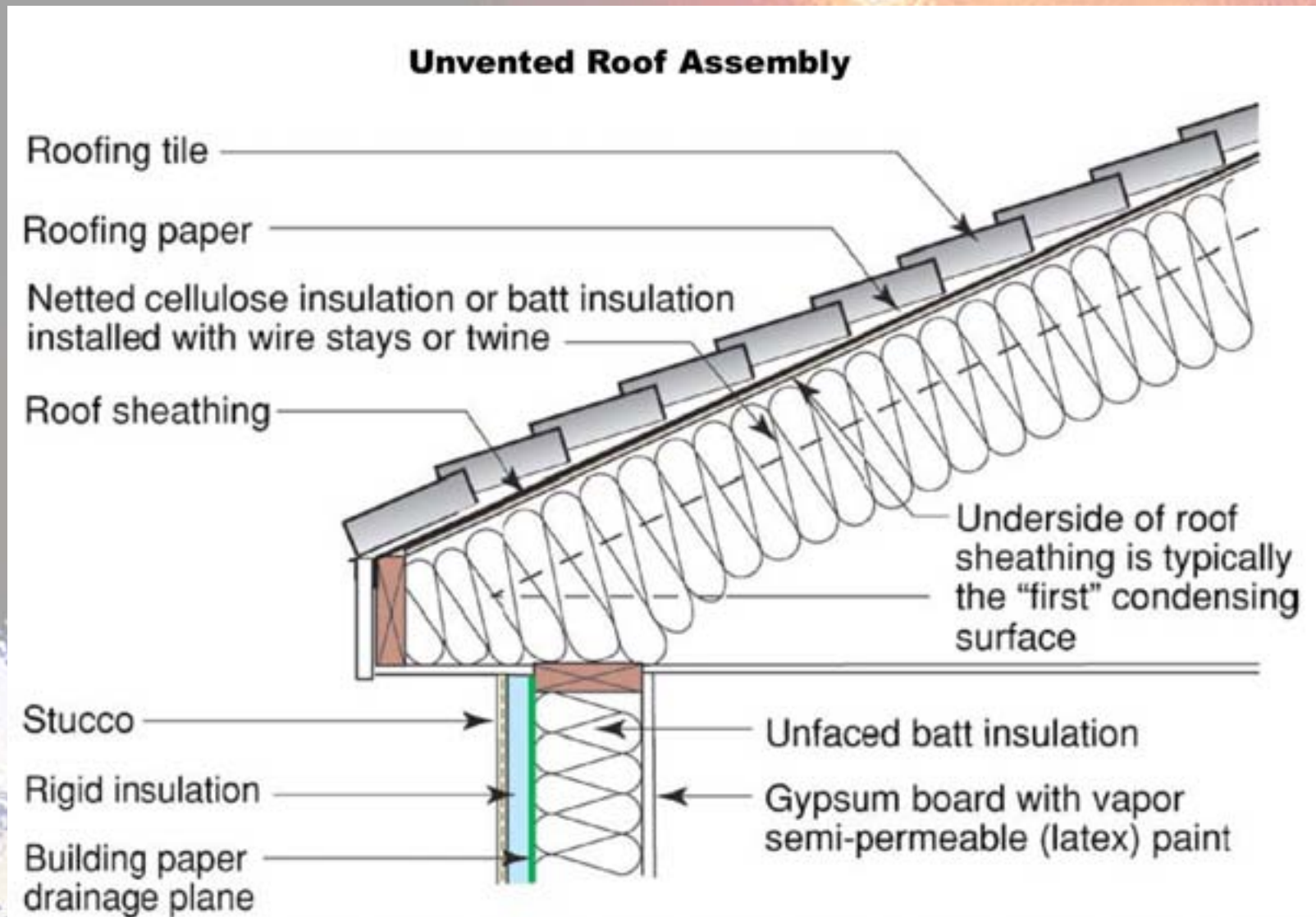
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Roofs



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Roofs



Source: BuildingScience.com

Keith Winston, Earth Sun Energy Systems

Crawl Spaces

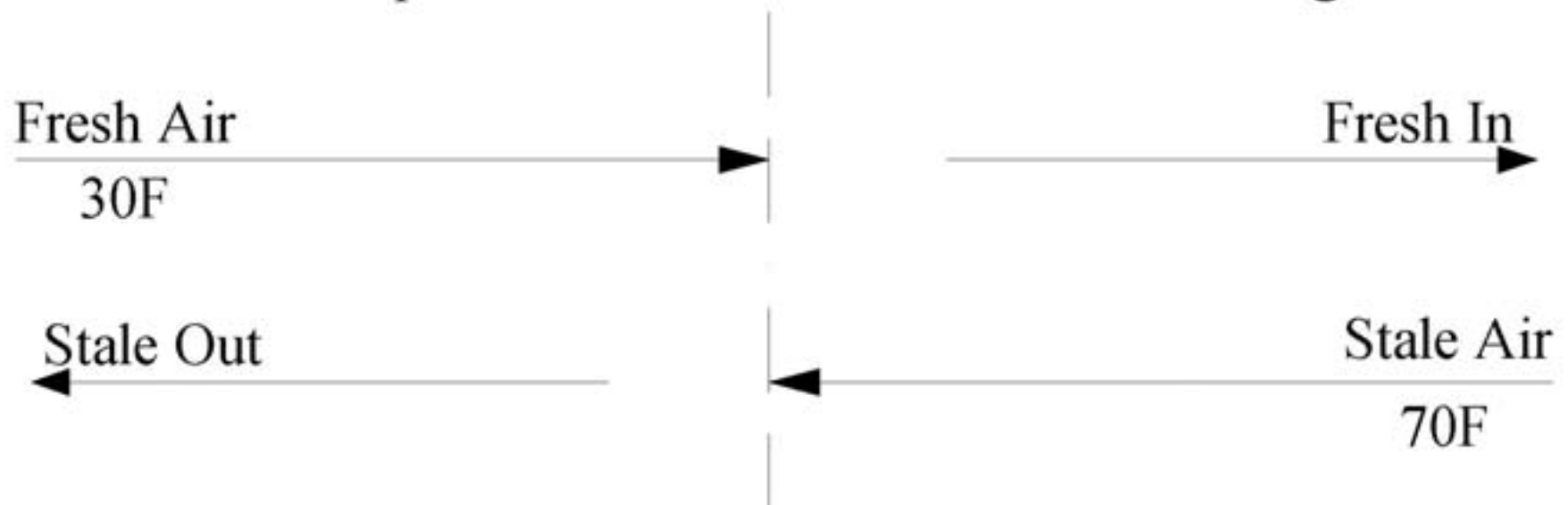
- Moisture
 - Vented vs. Conditioned Space
 - Vapor Barrier & Rat Slab
- Dehumidifiers

Ventilation & IAQ

- The Costs of Ventilation
- Energy Recovery Ventilators
- Counter-flow Heat Exchangers

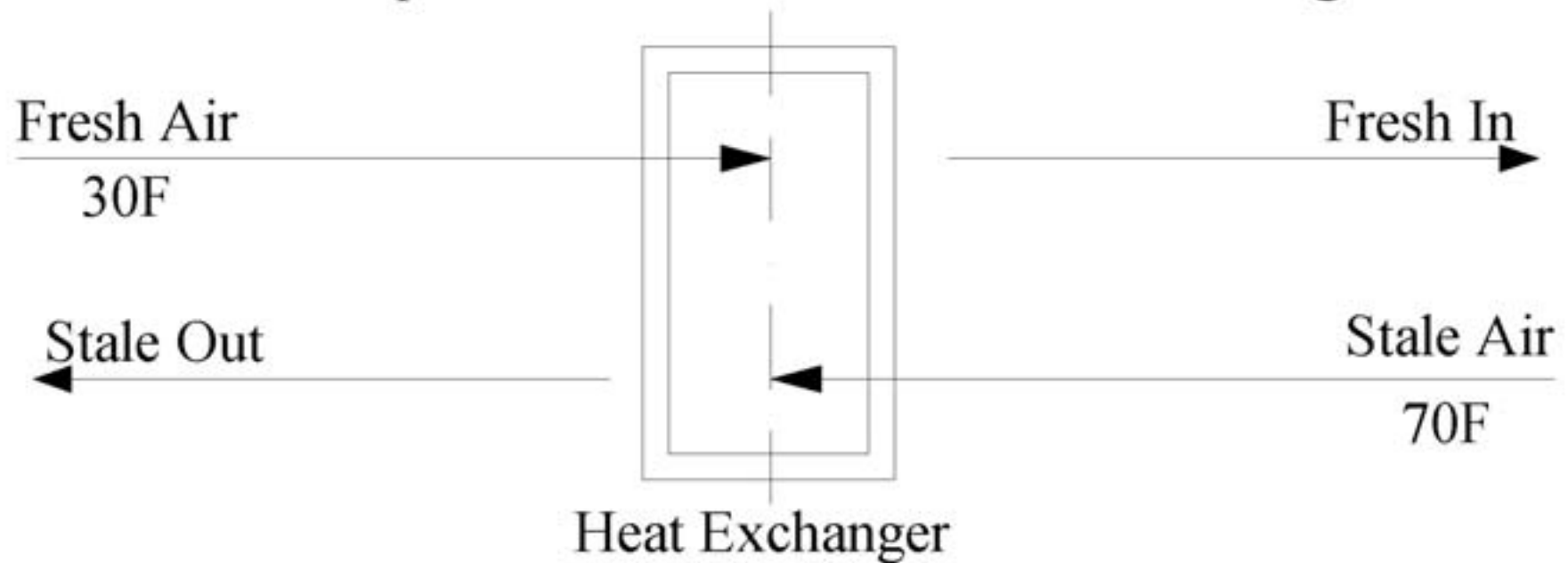
Counter-flow Heat Exchangers

Principles of Counter-Flow Heat Exchanger



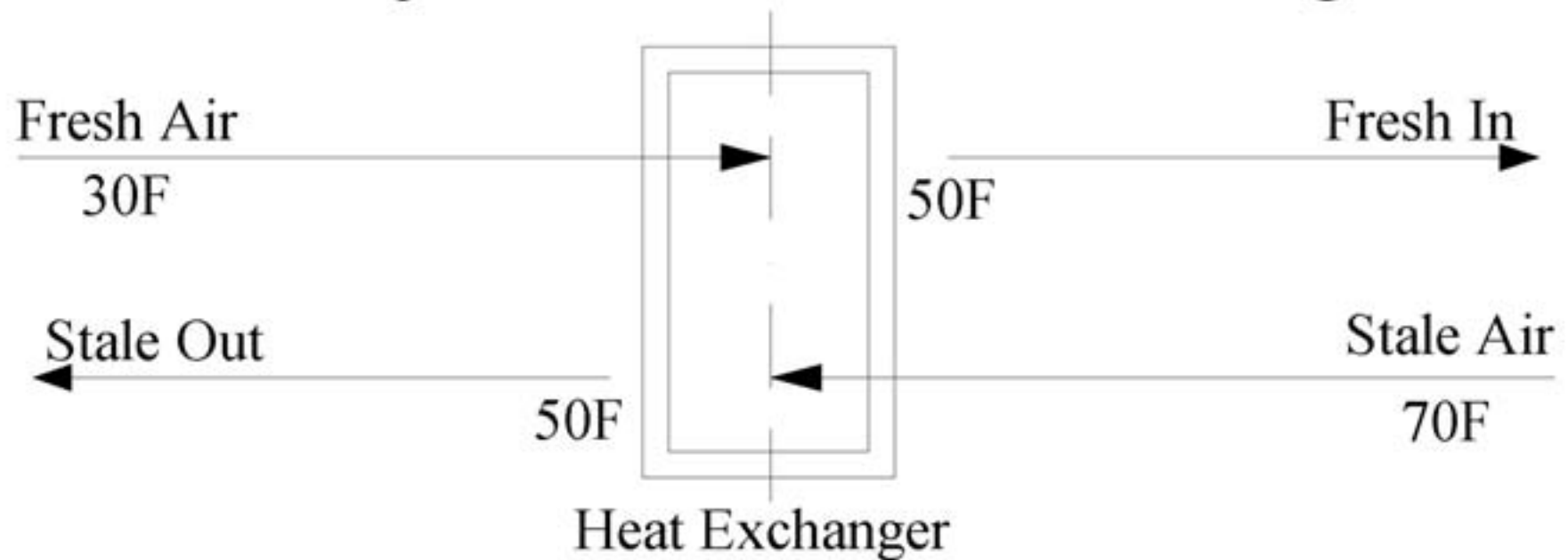
Counter-flow Heat Exchangers

Principles of Counter-Flow Heat Exchanger



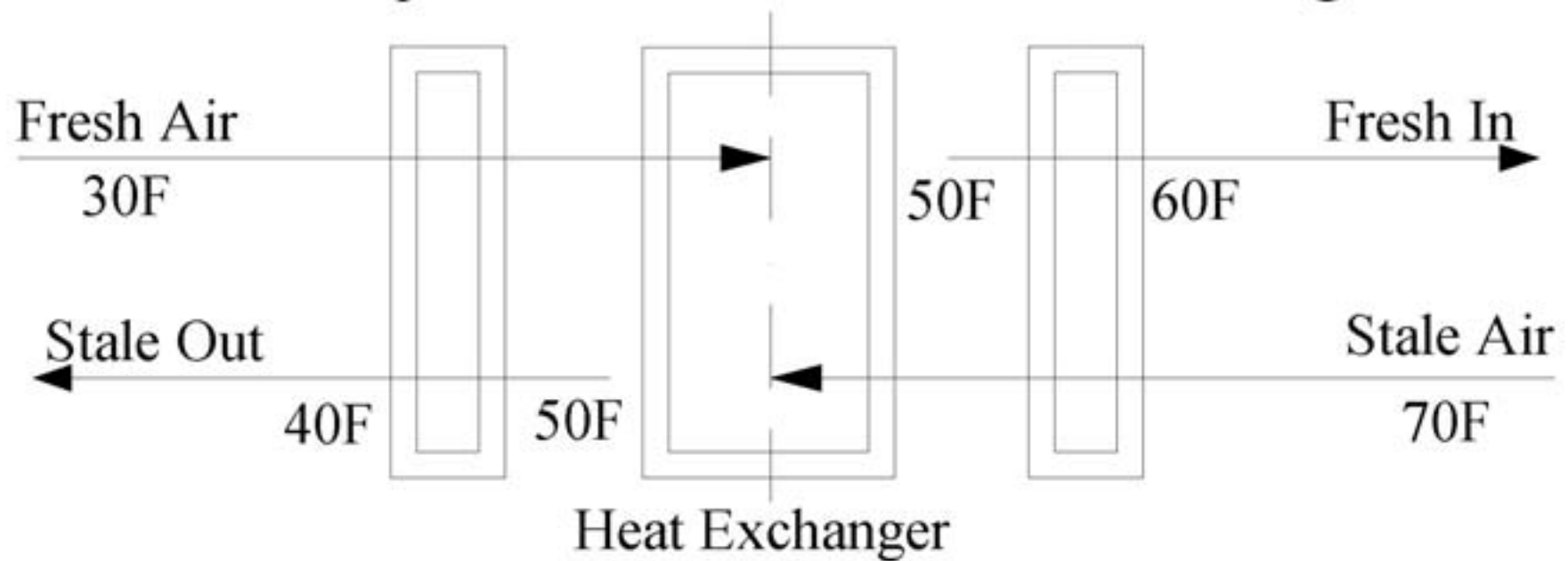
Counter-flow Heat Exchangers

Principles of Counter-Flow Heat Exchanger



Counter-flow Heat Exchangers

Principles of Counter-Flow Heat Exchanger



Heating & AC

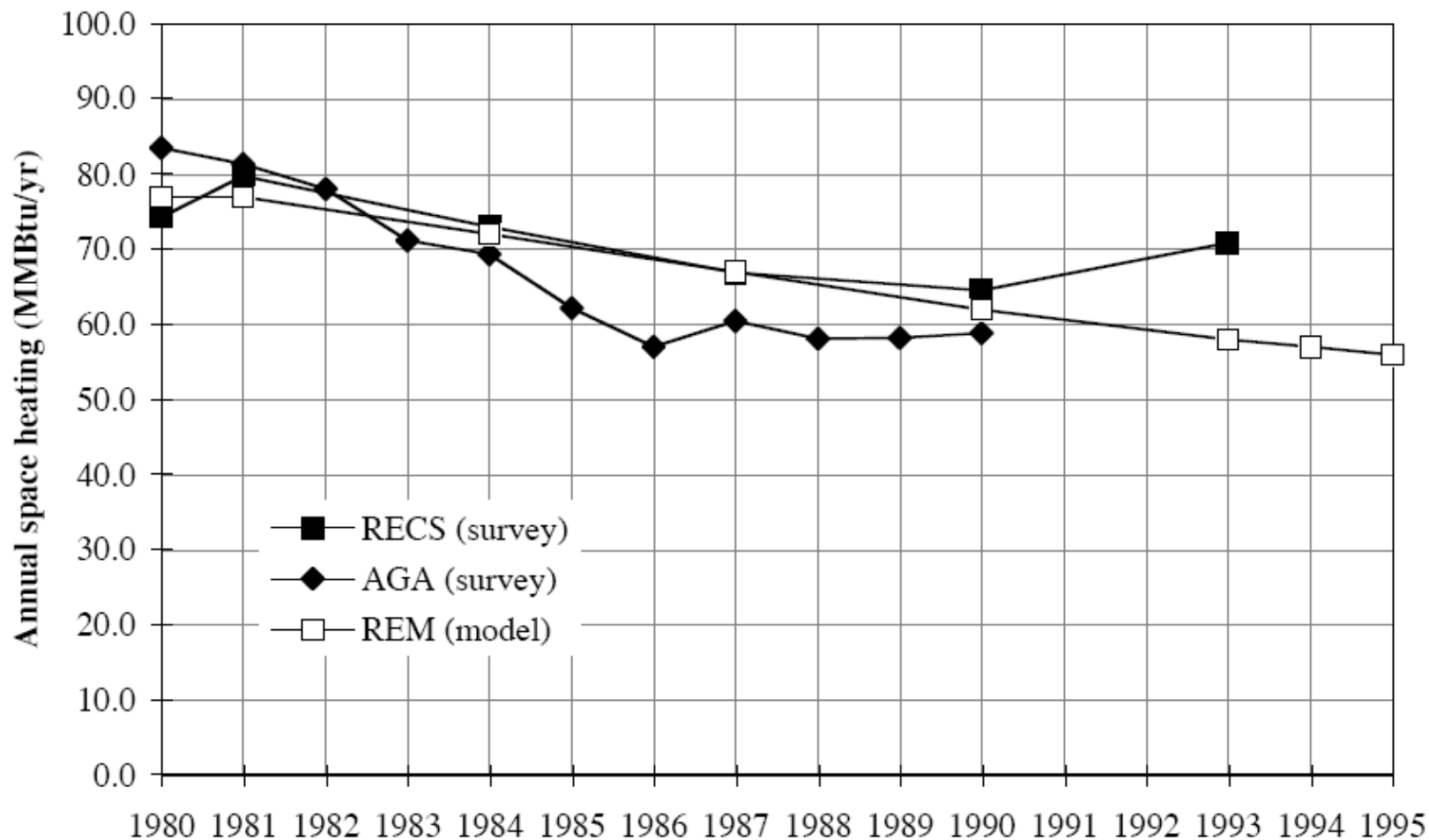
- Distribution Systems
- System Efficiency vs. Combustion Efficiency
- Chimneys

Heating & AC

- Distribution Systems
 - Hydronic
 - Convective
 - Radiant
 - Forced Air
 - 2-fer
 - Mini-splits

Energy Use: Gas Heating

Figure 3.2. National Average Gas Space Heating Consumption -- All House Types

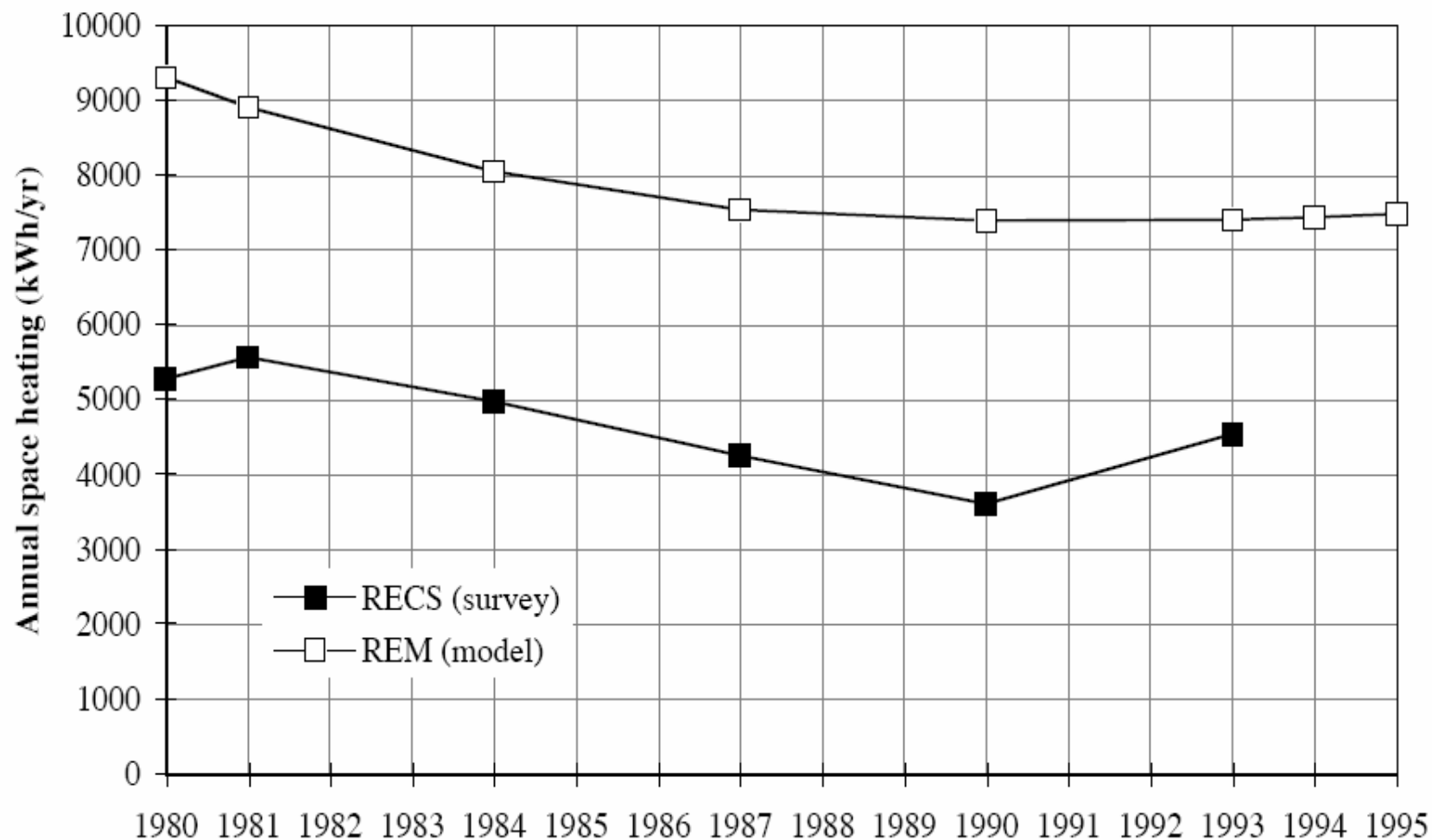


Source: US EIA

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Energy Use: Electric Heating

Figure 3.4. National Average Electric Space Heating Consumption -- All House Types



Source: US EIA

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Water Heating

- Tank vs. On-Demand
- Direct Vent
- SolarThermal
- GFX Drain Waste Heat Recovery

Energy Use: Water Heating

Table 4.1. Characteristics of water heaters

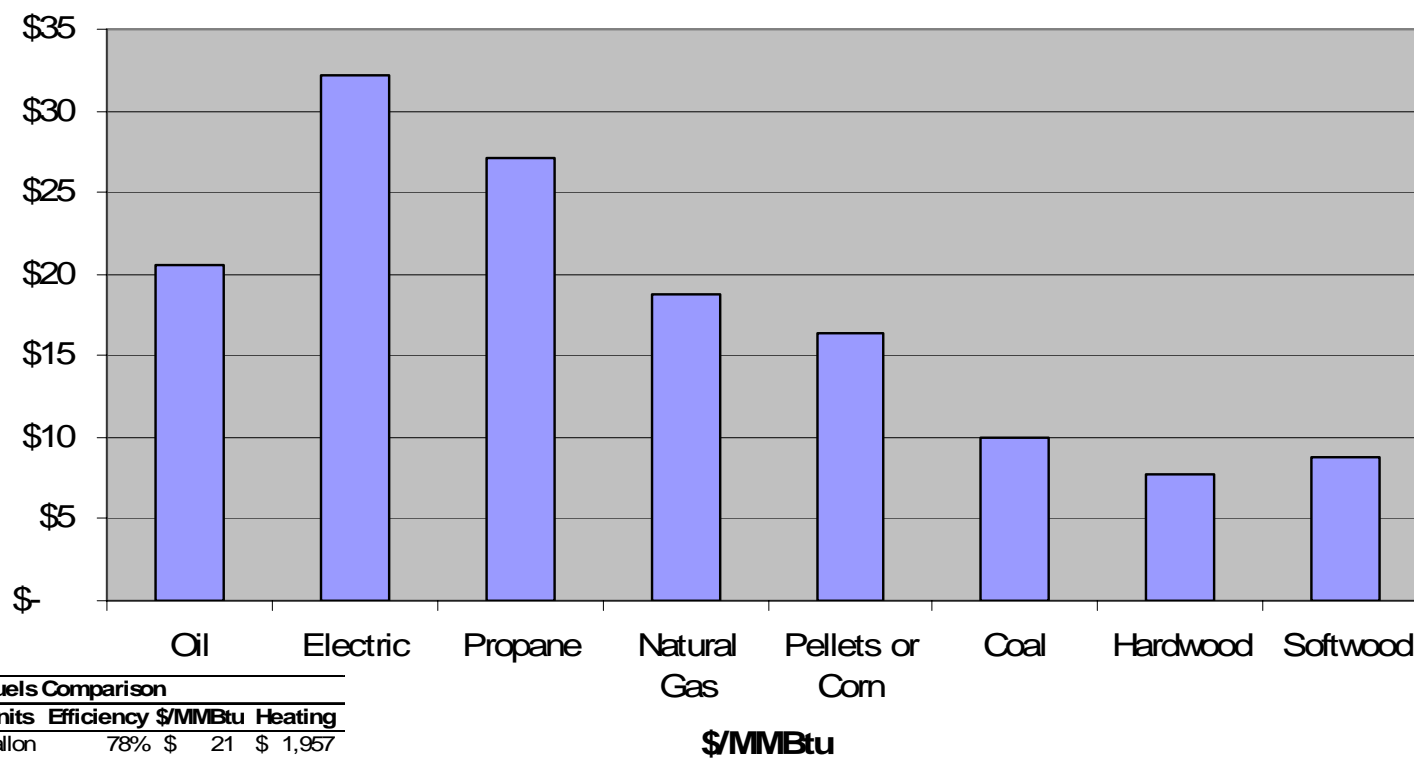
	Units	<i>Stock 1990</i>	<i>Stock 1993 w/1990 stds</i>	<i>New late 1980s</i>	<i>New 1990</i>	<i>Heat Pump Water Heater</i>
<i>Energy Factors</i>						
Electricity	%	82%	83%	84%	88%	189%
Gas	%	49%	50%	49%	54%	–
Oil	%	46%	46%	47%	51%	–
<i>Standby losses</i>						
Electricity	Wh.th/hr	97	89	86	57	10
Electricity	Btus.th/hr (site)	332	303	294	194	34
Gas	Btus.th/hr	1576	1453	1510	1125	–
Oil	Btus.th/hr	1576	1453	1510	1125	–
<i>Recovery efficiency</i>						
Electricity	%	98%	98%	98%	98%	193%
Gas	%	76%	76%	76%	76%	–
Oil	%	76%	76%	76%	76%	–

Fuel Choice

- Regional Availability & Common Usage
- Fossil Fuels
- Biofuels
 - Energy Balance
 - Carbon Cycling
- SolarThermal
- Geothermal

Energy Metrics

Fuels Cost Comparison



Cost of Fuels Comparison						
	Cost	Units	Efficiency	\$/MMBtu	Heating	
Oil	\$ 2.25	Gallon	78%	\$ 21	\$ 1,957	
Electric	\$ 11.00	kWh	100%	\$ 32	\$ 3,062	
Propane	\$ 1.90	Gallon	78%	\$ 27	\$ 2,568	
Natural Gas	\$ 1.50	Therm	80%	\$ 19	\$ 1,781	
Pellets or Corn	\$185.00	Ton	70%	\$ 16	\$ 1,557	
Coal	\$195.00	Ton	70%	\$ 10	\$ 953	
Hardwood	\$135.00	Cord	70%	\$ 8	\$ 732	
Softwood	\$100.00	Cord	70%	\$ 9	\$ 841	

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Energy Auditing

- Analysis vs. Action: Project Scale
- Blower Doors
- Thermal Imaging

Energy Auditing

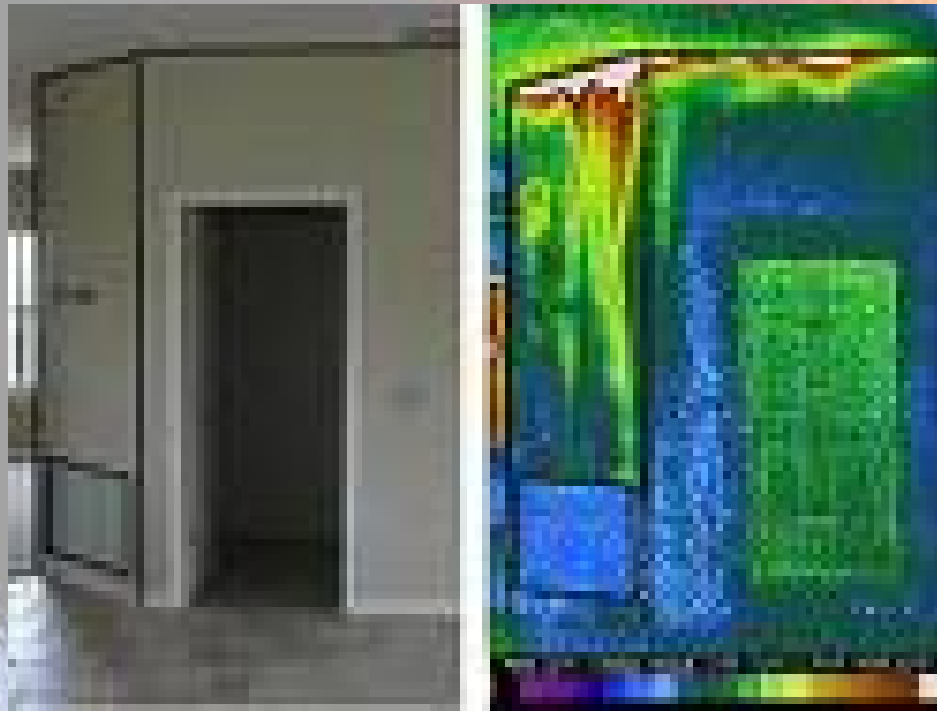
- Blower Doors



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Energy Auditing

- Thermal Imaging



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Conclusion

- Educate Yourself! (& Build a Team)
- “Build Tight, Ventilate Right”
- Scale Research & Design to the Project
- Bring Holistic Energy Considerations in on Day 1, or ASAP

Resources

- buildingscience.com
- solar-rating.org
- gfxtechnology.com